**Q1.**A paintball gun is used to fire a small ball of paint, called a paintball, at a target.

The figure below shows someone just about to fire a paintball gun.

The paintball is inside the gun.



(a)     What is the momentum of the paintball before the gun is fired?

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Give a reason for your answer.

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**(2)**

(b)     The gun fires the paintball forwards at a velocity of 90 m / s.

The paintball has a mass of 0.0030 kg.

Calculate the momentum of the paintball just after the gun is fired.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Momentum = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kg m / s

**(2)**

(c)     The momentum of the gun and paintball is conserved.

Use the correct answer from the box to complete the sentence.

|  |
| --- |
| **equal to                greater than                less than** |

The total momentum of the gun and paintball just after the gun is fired

will be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the total momentum of the gun and

paintball before the gun is fired.

**(1)**

**Q2.** The diagram below shows an ice skater, Skater A.



(a)  Write down the equation that links mass, momentum and velocity.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(b)  Skater **A** travels with a velocity of 3.2 m/s and has a momentum of 200 kg m/s

Calculate the mass of Skater **A**.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kg

**(3)**

(c)  Skater **A** bumps into another skater, Skater **B**. Skater **B** is stationary.

The skaters move off together in a straight line.

Explain what happens to the velocity of each of the skaters.

Use the idea of conservation of momentum.

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**(3)**

**Q3.** A swimmer dives off a boat.

Look at **Figure 1**.

**Figure 1**



(a)     What **two** factors determine the momentum of the swimmer?

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(b)     What is the unit of momentum?

Tick **one** box.

|  |  |
| --- | --- |
| J / s |  |
| kg m / s |  |
| N m |  |
| m / s2 |  |

**(1)**

(c)     The boat was stationary. As the swimmer dives forwards, the boat moves backwards.

Use the idea of conservation of momentum to explain why the boat moves backwards.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(4)**

Mark schemes

**Q1.**

(a)     Zero / 0

*Accept none*

*Nothing is insufficent*

**1**

velocity / speed = 0

*accept it is not moving*

*paintball has not been fired is insufficient*

**1**

(b)     0.27

*allow* ***1*** *mark for correct substitution, ie p = 0.003(0) × 90 provided no subsequent step*

**2**

(c)     equal to

**1**

**[5]**

**Q2.**

(a)  momentum = mass × velocity

*allow p = mv*

**1**

(b)  200 = m × 3.2

**1**



**1**

m = 63 (kg)

*allow 62.5 (kg)*

**1**

*an answer of 63 (kg) scores* ***3*** *marks*

(c)  (total) momentum before (collision) = (total) momentum after (collision)

**1**

**either**

momentum of skater A decreases and momentum of skater B increases

*allow (total) momentum is shared between skater A and skater B*

**1**

velocity of skater A decreases and velocity of Skater B increases

**1**

**or**

momentum of skater A decreases and so velocity of skater A decreases (1)

momentum of skater B increases and so velocity of skater B increases (1)

**[7]**

**Q3.**

(a)     mass

**1**

velocity

**1**

(b)     kg m / s

**1**

(c)     momentum before = momentum after

**1**

and before diving in the momentum of the diver and (small) boat is zero

**1**

after diving the diver has forwards momentum / momentum to the right

**1**

therefore the (small) boat has equal backwards momentum / equal momentum to the left

**1**

(d)     the boat moves back more slowly

**1**

because there is more mass (but momentum stays the same)

**1**

(e)     as she swims there is a drag force

**1**

as speed increases so does the drag force

**1**

she accelerates less

**1**

drag force = thrust force

*accept resultant force = 0*

**1**

the swimmer reaches terminal velocity

**1**

**[14]**